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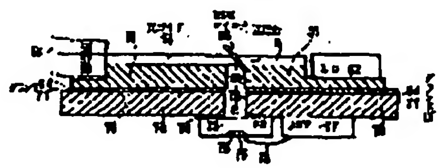
(54) OPTICAL TRANSMISSION AND RECEPTION MODULE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an inexpensive optical transmission and reception module which consists of a small number of components and is easily manufactured in high yield.
SOLUTION: This optical transmission and reception module consists of a filter 66 which is provided obliquely halfway in a light guide part of a 1st substrate 7 and reflects part of light downward and reflects the other light, an LD 62 which is provided at a step part of the 1st substrate 70 opposite an end part of a light guide 54, a 2nd substrate 51 which has a metallized layer 64 on the top surface and a 2nd longitudinal hole 72 at a position corresponding to a 1st longitudinal hole 68 and has the top-surface metallized layer joined with a metallized layer 64 on the reverse surface of the 1st substrate 70, a PD which is fitted onto the bottom surface of the 2nd substrate right below the longitudinal hole of the 2nd substrate 51, and an amplifier which is fixed on the bottom surface of the 2nd substrate and amplifies the photocurrent of the PD. The metallized layer at the border between the 1st substrate 70 and 2nd substrate 51 is at the ground potential and the tip of an optical fiber is fixed in the front V groove of the 1st substrate 70; and part of the light exiting from the optical fiber is reflected downward and made incident on the PD and the part from the LD 62 is partially transmitted through the filter and enters the optical fiber.



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CLAIMS

[Claim(s)]
[Claim 1] The V groove which is prepared in the 1st dugout dug by some of lightguides to which the light prepared in pars intermedia is led, and lightguides, and one edge, and fixes an optical fiber tip, the step which attaches LD in the edge of the opposite side, and the 1st substrate which has a metallized layer on a base, The filter which inclines in the middle of the lightguide section of the 1st substrate, is prepared, reflects a part of light caudad, and reflects a part of light, LD prepared in the step of the 1st substrate so that the edge of lightguide may be countered, The 2nd substrate with which it has the 2nd dugout which has a metallized layer on the top face and was established in the location corresponding to the 1st dugout, and the top-face metallized layer was joined to the metallized layer of the rear face of said 1st substrate, It consists of PD attached in the 2nd substrate base in directly under [of the dugout of the 2nd substrate]. The metallized layer of the boundary line of the 1st substrate and the 2nd substrate serves as ground potential, and the tip of an optical fiber is fixed to the V groove ahead of the 1st substrate. It is the optical transceiver module with which light from LD is characterized by a part penetrating a filter and making it go into an optical fiber by being caudad reflected by the filter and the part carrying out incidence of the light which came out of the optical fiber to PD.
[Claim 2] It is the optical transceiver module according to claim 1 which lightguide is straight-line-like optical waveguide and is characterized by the filter aslant prepared in the mid-position being a filter which reflects and penetrates one wave of light to a predetermined ratio, and a part of light from an optical fiber being reflected by the filter, light being received by PD, and a part of light of the same wavelength from LD penetrating a filter, and making it go into an optical fiber.
[Claim 3] The filter which lightguide is straight-line-like optical waveguide and is aslant prepared in the mid-position is a certain wavelength lambda 1. Wavelength lambda 2 of another ** which reflected about 100% and was emitted from laser Optical transceiver module according to claim 1 characterized by being the wavelength selectivity **** filter penetrated 100% of abbreviation.
[Claim 4] The optical transceiver module according to claim 1 to 3 characterized by forming lightguide of the optical waveguide of a quartz system.
[Claim 5] The optical transceiver module according to claim 1 to 4 characterized by a filter coming to form optical multilayers on the macromolecule thin film of translucency.
[Claim 6] The optical transceiver module according to claim 1 to 4 characterized by a filter coming to form optical multilayers on the glass substrate of translucency.
[Claim 7] The optical transceiver module according to claim 1 to 6 characterized by for a photodiode consisting of Si and semiconductor laser consisting of a GaAlAs system as a light emitting device.
[Claim 8] The optical transceiver module according to claim 1 to 6 characterized by for a photodiode having the euphotic zone of InGaAs or InGaAsP, and semiconductor laser consisting of an InGaAsP system.
[Claim 9] The optical transceiver module according to claim 1 to 8 characterized by a photodiode being a photodiode of a rear-face incoming radiational type.
[Claim 10] The optical transceiver module according to claim 1 to 9 characterized by having arranged

the amplifier near the photodiode.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the optical transceiver module which united the photo detector and the light emitting device with the optical fiber in the optical two-way communication which transmits information for the lightwave signal of two or more different wavelength between through, a base station, and a subscriber at an one direction or both directions.
[0002] [Explanation of optical two-way communication] The transmission loss of an optical fiber falls in recent years, and the property of semiconductor laser (it omits Following LD) or a semi-conductor photo detector (it omits Following PD) has improved. For this reason, transmission of various information using light is attained. Since it is the communication link using light, these techniques are called optical communication. There are a telephone, facsimile, a television picture signal, etc. as a gestalt of the information which should be transmitted. Especially, the attempt of the communication link of wavelength using the light of long wavelength, such as light of 1.3-micrometer band and light of 1.55-micrometer band, is performed briskly.
[0003] Recently, the system can transmit and receive a signal bidirectionally, and a signal can be transmitted [recently,] and received to delivery and coincidence using one optical fiber is examined. Since a signal is sent bidirectionally, it is called two-way communication. I hear that a fiber can be managed with one and it has the advantage of this method. Drawing 1 is the principle Fig. of wavelength multiplexing two-way communication using the light of different wavelength among such two-way communication. Two or more subscribers are combined with one station with the optical fiber. Here, the subscriber is illustrating only one. There are many junctions in fact, and the optical fiber from a station branched to many optical fibers on the way, and has resulted in a subscriber's equipment.
[0004] A station side amplifies the signal of a telephone or TV as digital one or an analog signal, and drives semiconductor laser LD1 with this signal. This signal is wavelength lambda 1. It becomes a signal and goes into an optical fiber 1. This is led to the middle optical fiber 3 with a splitter 2. Furthermore, it goes into an optical fiber 5 with the splitter 4 by the side of a subscriber, and is received by the photo detector PD 2. Photo electric conversion is carried out by the photo detector, and it becomes an electrical signal P3 by it. Signal processing of the electrical signal P3 is amplified and carried out by the equipment by the side of a subscriber, and it is reproduced as the voice or the television picture of a telephone. Thus, it gets down from the signal which goes to a subscriber side from a base station, and it is called a signal, gets down from the information flow of this direction, and is called a system.
[0005] On the other hand, a subscriber side is wavelength lambda 2 by semiconductor laser LD2 about the signal of a telephone or facsimile. It changes into a lightwave signal. lambda 2 Incidence of the light is carried out to an optical fiber 6, it is led to the middle optical fiber 3 with a splitter 4, passes along the splitter 2 by the side of a station, and is in a photo detector PD 1. The equipment by the side of a station is lambda 2. By PD1, photo electric conversion of the lightwave signal is carried out, and it is made into an electrical signal. This electrical signal is sent into the exchange or a digital disposal circuit, and receives suitable processing. Thus, the direction which sends a signal to a station side is gone up, and it is called a system. The signal is gone up and it is called a signal.
[0006] By the above explanation, it is lambda 1. It gets down and is a system and lambda 2. It is used only for the uphill system. However, the light of the same wavelength may be used for going down and going up in fact. Occasionally, going up and both from which it gets down may be made to spread all of the light of two kinds of wavelength. In such a case, separation of two light from which wavelength is different becomes a very important problem.
[0007] In order for one optical fiber to perform two-way communication using [explanation of the splitter of light], thus the light of two wavelength, the function by the side of a station and a subscriber for both to identify the wavelength of **** and to separate an optical path is needed. The splitters 2 and 4 in drawing 1 achieve the function. A splitter is wavelength lambda 1 and lambda 2. There is an

operation which introduces into one optical fiber, or chooses only one light and is taken out from the light of two wavelength to one optical fiber light unitedly. A role with a very important splitter is played in performing wavelength multiplexing two-way communication.
[0008] There are some classes of the splitters by which the current proposal is made. Drawing 2 - drawing 3 explain. A splitter is made from the example of drawing 2 by an optical fiber or optical waveguide. Two optical paths 8 and 9 are close by 10 in part, and exchange of light energy is made here. Association of various modes is realizable with spacing D and distance L of the contiguity section 10. Here, it is lambda 1 to an optical path 8. When incidence of the light is carried out, it is lambda 1 to an optical path 11. Light comes out. Optical path 12lambda2 When light is put in, it is lambda 2 to an optical path 9. Light comes out. This is the splitter of a waveguide mold.
[0009] Being shown in drawing 3 uses a multilayers mirror. Dielectric multilayers are formed in the oblique side side of the isosceles triangle column-like glass blocks 13 and 14. The refractive index and thickness of a dielectric are combined suitably and it is lambda 1. All light penetrates and is lambda 2. He is trying to reflect all light. This has the function which is made to reflect the light which carried out incidence at the include angle of 45 degrees, or is made to penetrate. This splitter can also be used as splitters 2 and 4 of drawing 1 . Such a splitter is also called spectral separation / multiplexing machine. It may be called WDM. What is depended on an optical fiber or a glass block is already marketed.
[0010]
[Description of the Prior Art] Drawing 16 explains the optical transceiver module by the side of a subscriber. In drawing 16 , the termination of the optical fiber 16 laid towards the subscriber from the office is connected to the indoor optical fiber 18 by the optical connecter 17. Optical fiber WDM21 (splitter) is formed in the ONU module in indoor [of a subscriber]. The optical fiber 18 and the optical fiber 19 are combined in wavelength selection inside WDM21. An optical connecter 22 ties the LD module 25 to an optical fiber 18. The PD module 27 is connected to an optical fiber 19 through an optical connecter 23.
[0011] LD25 and an optical fiber 24 make an uphill system. 1.3-micrometer **** transmits the signal by the side of a subscriber to a station. An optical fiber 26 and the PD module 27 get down, and are a system. In response to 1.5-micrometer band signal from a station, photo electric conversion is carried out with PD module. LD25 which is a sending set amplifies the signal of a telephone or facsimile, and contains the circuit to modulate, the semiconductor laser which changes an electrical signal into a lightwave signal. The PD module 27 which is a receiving set includes the photodiode which carries out photo electric conversion of the lightwave signals sent from the station, such as TV signal and a telephone, an amplifying circuit, a demodulator circuit, etc.
[0012] The wavelength splitter (WDM module) 21 has the operation which separates 1.5-micrometer **** and 1.3-micrometer ****. In this example, 1.3-micrometer **** is gone up, and it considers as the signal of a system, gets down from 1.5-micrometer ****, and uses as a signal of a system. This invention relates to amelioration of the optical transceiver module in the case of carrying out two-way communication using the lightwave signal of two different wavelength. An optical transceiver module includes a light emitting device, photo detectors, these circumference electrical circuits, etc. The conventional technique about these elements is explained.
[0013] The semi-conductor light emitting device (LD module) 28 which starts the conventional example by [explanation of semi-conductor light emitting device (LD module) concerning conventional example] drawing 4 is explained. It is a module including the semiconductor laser chip (LD) 29 and the photodiode chip 30 for monitors. The LD chip 29 is fixed to the last side face of the ridge (pole) 31 of a header 32. It is because a light parallel to the front face of LD chip is generated. The PD chip 30 is fixed to the location as for which tooth-back luminescence of LD carries out incidence to the base of a header 32. There is an adequate several lead pin 33 in the inferior surface of tongue of a header 32. The component clamp face of a header 32 is covered with cap 34.
[0014] It comes out of the light of the semiconductor laser (LD) in which the aperture 35 is carrying out opening to the center section of the cap 34 in the vertical direction from a chip. There is a lens 37 in right above [of an aperture 35]. This is supported by the lens holder 36. Upwards housing 38 is and a

ferrule 39 is fixed to the pan of a lens holder 36 by the upper crowning of this. A ferrule 39 holds the tip of an optical fiber 40. The ferrule and the edge of an optical fiber are ground aslant. It is for preventing reflective return light going into LD29.
[0015] Supervising the light of semiconductor laser (LD) 29 in the other end of an optical fiber 40, an electrode holder 36 is positioned to a header 32, and housing 38 is further positioned to a lens holder 36. Each electrode of semiconductor laser 29 and a photodiode 30 is connected to either of the lead pins 33 by the wire.
[0016] Incidence of the light which came out of semiconductor laser is carried out to the edge of a rat tail and an optical fiber with a lens. Since semiconductor laser is modulated by the signal, this light will transmit a signal. The monitor of the output of semiconductor laser is carried out by the photodiode 30 for monitors in the opposite side. The oscillation wavelength of 1.3 micrometers - 1.5 micrometer band is decided with the ingredient of a semi-conductor layer.
[0017] PD module concerning the conventional example is explained to [explanation of semi-conductor photo detector module concerning conventional example] drawing 5 . Die bond of the photo detector chip 41 is carried out to the top face of a header 42. The lead pin 43 is formed in the inferior surface of tongue of a header 42. The top face of a header 42 is covered with cap 44. There is opening 45 for letting light pass in the center of cap 44. The electrode holder 46 of a cylindrical shape is further fixed to the outside of a cap. This is for holding a lens 47.
[0018] Upwards, the housing 48 of a cone form is fixed to the pan of a lens holder 46. The tip of an optical fiber 50 is fixed by the ferrule 49. A ferrule 49 is held with housing. Slanting polish of a ferrule and the tip of an optical fiber has been carried out.
[0019] The location of an electrode holder 46, the location of housing 48, and the location of a ferrule are decided supervising the output of through and the PD chip 41 for light to an optical fiber also in a photo detector. The wavelength range which can receive light is decided by the semi-conductor layer of a photo detector. In the case of the light, PD of Si can be used. PD of Si is unsuitable when aimed at the transceiver module using near-infrared light. In order to pick up near-infrared light, it is necessary to use the photo detector of the compound semiconductor which uses InP as a substrate (a euphotic zone is InGaAs or InGaAsP).
[0020]
[Problem(s) to be Solved by the Invention] Many are the general homes of the subscriber of optical two-way communication most. Therefore, only the number of a certain telephones should have a commercial scene now. However, if it is not made cheap like the telephone by the ordinary metal line, it will be hard to purchase ordinary homes. It is necessary to make a module into a low price. However, in the combination of the module according to individual of the former of drawing 3 (LD module, PD module, WDM module), it will grow into the total price of an individual module price, and will become expensive. That such a module is expensive has barred progress of an optical subscriber system. A cheap device which feels inclined for a consuming public to purchase must be prepared.
[0021] Then, some attempts which reduce components mark and which are used more as a compact in which it is made low cost more are proposed and released. Some of modules newly proposed by drawing 6 , drawing 7 , and drawing 8 are shown. All have a new advantage. If it sees from a ******** person, in addition, it is inadequate and each has a fault.
[0022] [A. The Institute of Electronics, Information and Communication Engineers ERETORONIKUSU society convention, C-208, and p208 (1996) have proposed the mirror form WDM component in horizontal reflective WDM mold (drawing 6)] Ogusu [Masahiro], Tazuko Tomioka, and Oshima **** "receptacle form bidirectional wavelength multiplexing light module" 1996. The module using WDM of a mirror mold is shown in drawing 6 . The WDM filter 81 was leaned in the direction of the diagonal line 45 degrees, and is set in the center of the rectangular housing 80. LD83 and PD85 are installed in two side faces of housing 80. The lens 82 is installed between WDM81 and LD83. The lens 84 is formed between WDM81 and PD85. The optical fiber 86 and the lens 87 are formed on the straight line which connects the core of LD83 and WDM81. Transmitting light lambda 1 from LD WDM is penetrated and incidence is carried out to an optical fiber. Signal light lambda 2 from the others from an

optical fiber It is reflected in a longitudinal direction by WDM, and goes into PD85. Since the engine performance of transparency and reflection changes with wavelength, two different wavelength is separated. However, this is as practically equal as the thing of drawing 3 . It is on extension of the conventional thing to use arrangement of the gestalt of LD and PD, a condenser lens, etc. and WDM etc. Cost reduction is also inadequate. It is not great amelioration. It is necessary to decrease components mark more.
[0023] [B. Y branch waveguide mold]N.Uchida, H. Yamada and Y.Hibino, Y. Suzuki and T.Kurosaki, N. Ishihara and M.Nakamura, T. Hashimoto and Y.Akahori, Y. Inoue and KMoriwaki, KKato, Y.Tohmori, and M.Wada, and T.Sugie and "LOW-COST AND HIGH-PERFORMANCE HYBRID WDM MODULE INTEGRATED ON A PLC PLATFORM FOR FIBER-TO-THE-HOME", 22 nd European Conferenceon Optical Communication-ECOC'96, OSLO, TuC.3.1, and P2.107 (1996) The WDM component of a branching waveguide mold It has proposed. Drawing 7 is a transceiver module using the optical waveguide of the quartz system which embedded WDM. The quartz waveguides 89, 90, 91, 92, and 93 which branch on a substrate 88 are formed. The waveguides 90 and 91 which carry out Y mold branching turned into the unified waveguide 89, and are connected with pan another Y branch waveguides 92 and 93. The WDM filter 102 is installed in the branch point of Y branch. PD99 is formed in the point of the branching waveguide 90 at the tip of Y branch 89. LD98 is formed at the tip of the branching waveguide 91. The electrode patterns 96 and 97 are formed in a substrate side. PD99 and LD98 are soldered on it. 1.3 micrometers goes away from the end face 100 of LD98, the WDM filter 102 is penetrated, and outgoing radiation is carried out as a free-space light 95 from waveguide 93. 1.3-micrometer signal from a base station passes WDM102 from waveguide 93, goes to waveguide 90, and goes into the end face 101 of PD99. This is PD of an end-face incoming radiational type. A WDM filter reflects 1.55 micrometers and penetrates 1.3 micrometers.
[0024] This does not have a lens and structure is simplified for a while. Going and returning are also 1.3 micrometers, and signal light is used in order that a WDM filter may only return light (1.55 micrometers) outside. Therefore, it cannot be used for the application (2 wave lambda1 and lambda 2 use) now considered by this invention. This method changes the travelling direction of light in an optical waveguide side. Naturally there is loss by waveguide in addition to loss of 1/2 by branching. Moreover, detailed optical waveguide must be formed on a substrate and manufacture is very difficult.
[0025] [C. Upper part reflective mold (drawing 8)] Tomoaki Uno, Nishikawa **** Masahiro Mitsuda, Motoji Tomon, A Matsui ** "LD/PD integration module of surface mount mold" 1997 Institute of Electronics, Information and Communication Engineers electronics society convention, C-3-89, p198 (1997), And Motoji Tomon, Tomoaki Uno, Naoki Takenaka, Nishikawa **** Hiroaki Asano, a Matsui ** "light-receiving property of PD module using fiber embedded optical circuit" 1997 Institute of Electronics, Information and Communication Engineers synthesis convention, C-3-59, and p244 have proposed the WDM component which reflects light up. Drawing 8 is the optical transceiver module it was made to reflect receiving light up. On the Si substrate 105, longwise V groove 108 is dug and an optical fiber 104 is fixed on this. A level difference 106 is in the trailer of a substrate 105, and LD107 is fixed. 1.3-micrometer light of LD107 is entered and transmitted to an optical fiber. There is slitting 110 which cut the substrate 105 and the optical fiber at the include angle of 45 degrees in common, and insertion immobilization of the WDM filter 111 is carried out here. PD109 is attached so that a light-receiving side may become downward in the slanting upper part.
[0026] 1.55-micrometer light which has spread the optical fiber 104 is reflected in the slanting upper part by the WDM filter 111. This is received by PD109. WDM reflects 1.55 micrometers of through for 1.3 micrometers like the thing of drawing 6 or drawing 7 . Since 1.55 micrometers is reflected in PD on slant, WDM is inclined and attached in slanting facing up. There is no lens, there is also no optical waveguide, and structure is simple. However, this serves as a pig taele type with which LD adhered behind the fiber. It seldom changes to the thing of drawing 3 after all.
[0027] Anyway, the cost of materials, assembly expense, etc. increase, the optical transceiver module proposed in recent years is large-sized, and its structure is not in addition simple. All are only mere extension of the present technique. yet -- a defect -- it does not come to present practical use mostly. It

gathers up, and is not mere association but smaller components mark, and the mere thing [offering a smaller optical transceiver module] of a present condition module is the 1st purpose of this invention. It is the 2nd purpose of this invention to offer the optical transceiver module which can also make cost-of-materials and assembly expense cheap. Speaking more concretely, are compacter than the thing of drawing 6 , being easy to make rather than the thing of drawing 7 , and offering the good optical transceiver module of the yield by the low price rather than drawing 8 .

[0028]

[Means for Solving the Problem] Optical transceiver module of this invention The V groove which is prepared in the 1st dugout dug by some of lightguides to which the light prepared in pars intermedia is led, and lightguides, and one edge, and fixes an optical fiber tip, the step which attaches LD in the edge of the opposite side, and the 1st substrate which has a metallized layer on a base, The filter which inclines in the middle of the lightguide section of the 1st substrate, is prepared, reflects a part of light caudad, and reflects a part of light, LD prepared in the step of the 1st substrate so that the edge of lightguide may be countered, The 2nd substrate with which it has the 2nd dugout which has a metallized layer on the top face and was established in the location corresponding to the 1st dugout, and the top-face metallized layer was joined to the metallized layer of the rear face of said 1st substrate, PD attached in the 2nd substrate base in directly under [of the dugout of the 2nd substrate], It consists of amplifier which is fixed to the 2nd substrate base and amplifies the photocurrent of PD. The metallized layer of the boundary line of the 1st substrate and the 2nd substrate serves as ground potential, and the tip of an optical fiber is fixed to the V groove ahead of the 1st substrate. It is caudad reflected by the filter and the part carries out incidence of the light which came out of the optical fiber to PD, and a part penetrates a filter and he is trying for the light from LD to go into an optical fiber.

[0029]

[Embodiment of the Invention] Each object introduced as a conventional example bends a part of light to the side, or is bending it up. As compared with these conventional example, this invention completely differs in the way of thinking. Light is not reflected in the side or the upper part and this invention reflects light below. This is one description. This invention separates the transmitting section and a receive section for an optical transceiver module up and down, makes the separate module, inspects it, chooses an excellent article, joins together, and let it be a transceiver module. Since it can manufacture separately, the yield goes up. Since the transmitting section and a receive section are separated up and down, it is necessary to reflect light caudad. Therefore, a filter is leaned and attached downward.

[0030] Even if it calls it a filter, there are two kinds of cases. One is the light lambda 1 of single wavelength. It is the case where it uses. in that case, transmitting light -- lambda 1 and receiving light -- lambda 1 it is . It is made for the timing of transmission to differ from the timing of reception. This is called ping-pong transmission. In this case, it reflects a part and a filter penetrates transmitting light and receiving light in part.

[0031] Another filter is a filter with wavelength selection nature. lambda 1 and lambda 2 Two kinds of light is used and it is lambda 1. lambda 2 When distributing and using for transmission and reception, it is necessary to separate these completely. A filter for that is called WDM filter. In this invention, receiving light is caudad reflected with a WDM filter, and transmitting light penetrates a WDM filter.

[0032] Furthermore, another description of this invention is that prepared lightguide on the substrate and it inserted the WDM filter in the midpoint. It is simple straight-line-like lightguide. Moreover, the light from which wavelength differs by WDM is separated. A certain wavelength lambda 1 It goes straight on and they are other wavelength lambda 2. It is reflected caudad. PD is prepared in the reflected lower part and this is received.

[0033] although this invention makes lightguide -- this -- the shape of a straight line -- manufacture -- it is easy. Although lightguide is made, neither the WDM coupler by surface waveguide (PLC) like drawing 7 nor formation of a filter is performed. The so-called so-called PLC means the optical circuit (Planar Lightwave Circuit) by flat-surface waveguide. The waveguide type principal part of drawing 7 is made of this PLC. The difficulty of the manufacture is as point **. This invention does not use optical waveguide. This invention uses the lightguide of a simple straight line. Although it is the lightguide of a

single mode, of course, it is a straight line and there is neither the curvilinear section nor branching. Therefore, the lightguide of the module of this invention can be cheaply manufactured by the high yield.

[0034] The sectional view of the lightguide used for drawing 10 by this invention is shown. When the extended direction of a guide is taken to a x axis, this is yz sectional view. It is SiO2 on the Si substrate (Si bench) 51. There is a buffer layer 52 and it is SiO2 on it. There is a layer. SiO2 It is germanium addition quantity refractive index SiO2 to the center section of the layer 51. There is a layer 54. SiO2 of the part surrounding this It is the cladding layer 53 of a low refractive index. The part 54 of a core has the operation which a refractive index is slightly high and draws light for germanium. This lightguide is a straight line and neither deflection nor branching exists.
[0035] The manufacture approach of lightguide is explained. SiO2 of a low refractive index [top / Si substrate 51 (for example, 15mmx20mmx1mm)] A buffer layer 52 is formed by the flame depositing method or the sputtering method. further -- a it top -- SiO2 [of thickness, for example, 50-micrometer germanium content,] of a high refractive index A layer is formed in the whole surface. Subsequently, a mask with a stripe pattern is used and it is the germanium content SiO2 by the photolithography. It leaves a part of center section for a layer, and both sides are removed. The high refractive-index section 54 remains on a buffer layer 52 by this. The cross section of this is 8micrometerx8micrometer. Subsequently, the cladding layer 53 of a low refractive index is formed by the flame depositing method or the sputtering method. The high refractive-index section 54 is surrounded by the cladding layer. The high refractive-index section 54 has a refractive index higher than a cladding layer 53 about 0.3%. It becomes the lightguide 54 to which this leads light in a core. The high refractive-index section 54 of the shape of this straight line is henceforth called lightguide 54.
[0036] The module of this invention consists of a superstructure and a substructure object, and makes both rival. A superstructure is shown in drawing 9 and a substructure object is shown in drawing 11. The lightguide of drawing 10 is prepared in a superstructure.
[0037] Drawing 9 explains a superstructure. Drawing 9 (a) is the top view of a superstructure, and (b) is central drawing of longitudinal section. On the front face of the 1st substrate 51 of flat Si, when the above-mentioned straight-line-like lightguide 54 dopes germanium to a longitudinal direction (the direction of a x axis), it is formed. There is a stage 55 in one end face of x directions, and V groove 67 is cut in the x directions in this center. The base of a V groove is formed so that it may agree in lightguide 54. The point of a single mode fiber 56 is put into V groove 67, and is positioned. An optical fiber end face is pasted up on the end face of a stage in the location. A single mode fiber 56 consists of a main core 57 and a clad 58 which surrounds this. A core diameter is about 10 micrometers. V groove 67 and a level difference 55 are made into a suitable geometry, and it is made for lightguide 54 and a core 57 to have agreed in the x directions. The metallizing side 64 is formed in the whole rear face of the 1st substrate 51. This is a gold layer. This is a layer which also becomes a grand side.
[0038] There is a level difference 59 in the side and the opposite side in which the optical fiber of the 1st substrate 51 is attached. The electrode patterns 60 and 61 are formed in the top face of a level difference 59. Bond of the LD chip 62 is carried out on one electrode pattern 60. LD can be attached in an electrode pattern using solder like AuGe. The electrode of the top face of the LD chip 62 is connected to the electrode pattern 61 of another side by the wire 63. Let the LD chip 62 be 1.3-micrometer luminescence laser of for example, an InGaAsP system. The dimension of a chip is 300micrometerx300micrometerx100micrometer.
[0039] The slanting slot 65 of the slanting lower part sense is dug by the midpoint of lightguide 54. The slanting slot 65 is dug in the direction which inclined 45 degrees in the -x direction to yz side. Insertion immobilization of the WDM filter 66 is carried out aslant in the slanting slot 65. The 1st dugout 68 is dug by the lower part independently [the slanting slot 65]. WDM is dielectric multilayers, and has the thickness of about 30 micrometers, and 1.3 micrometers (through and 1.55 micrometers) are reflected.
[0040] The transmitting light S (for example, 1.3 micrometers) which came out of back LD62 enters at the tip of lightguide 54, passes along the WDM filter 66, passes through lightguide 54 in the -x direction, and it carries out incidence to the core 57 of an optical fiber 56. The receiving light R (for

example, 1.55 micrometers) which has spread the optical fiber goes into lightguide 54, progresses in the +x direction, and it is reflected by the WDM filter 66 and it progresses below through a dugout 68. A photo detector is prepared here and light is received by this so that it may state later. That is, receiving light is not the side, either, is not the upper part, either, and is caudad bent by WDM.
[0041] Drawing 11 explains a substructure object. On the 2nd substrate 70 of a flat rectangle-like insulator, a metallized layer 71 is formed uniformly. This also serves as a plane of composition and also serves as a grand side. It is metallizing by gold etc. Let the 2nd substrate 70 be a ceramic. The 2nd dugout 72 is dug in the center section by the location corresponding to the dugout 68 of point **. The metallizing electrode patterns 74 and 79 are formed in the inferior surface of tongue of the 2nd substrate 70. The electrode pattern 74 is in the surroundings of the 2nd dugout 72. PD73 of a rear-face incoming radiational type turns a rear face up, and is soldered here. This PD73 has the dimension of for example, 550-micrometer angle x100-micrometer thickness. The rear-face incoming radiational type PD is the photo detector light carries out incidence from n mold substrate side, and it was made to result in the euphotic zone which it is near the p field through a buffer layer.
[0042] As for a photo detector, the light-receiving wavelength range is decided with the ingredient of a euphotic zone and a window layer. For example, PD which makes InGaAs a euphotic zone for receiving 1.55 micrometers and 1.3-micrometer band is used. When saying that only 1.3 micrometers is received, PD which makes InGaAsP a euphotic zone can be used. All of a substrate are InP crystals. Drawing 12 describes an example of the rear-face incidence PD. On the n-InP substrate 141, the epitaxial wafer to which epitaxial growth of the n-InP buffer layer 142, the n-InGaAs euphotic zone 143, and the n-InP window layer 144 was carried out is used. A mask is used for this, Zn is diffused on the top face, and p mold fields 145, 146, and 147 are made. Central p mold field 145 serves as a light sensing portion. Even if light goes into this part and p mold fields 146 and 147 of the side can do an electron-hole pair, they are for abolishing signal delay, as it does not flow into an electrode and does not become a photocurrent.

[0043] Pn junction 150, 151, and 152 arises for Zn diffusion. Central pn junction contributes to detection. The pn junction 151 and 152 of an edge prevents transit of the aforementioned excessive carrier. On central p mold field 145, the p electrode 149 of 60-micrometer diameter is formed. Since incidence is not carried out from a front face, p electrode is not a ring-like. There is no opening. It is the shape of a small (60 micrometers) circle. p mold field 145 the very thing is also narrow. Therefore, the electrostatic capacity of pn junction becomes small.
[0044] The ring-like n electrode 153 is formed in the rear face of the n-InP substrate 141. Although the area of this is large, it does not interfere. Although central opening is 200micrometerphi, light enters here. Opening is covered with an antireflection film 154.
[0045] Since it is a rear-face incoming radiational type, incidence is carried out from n mold substrate side. n electrode on the back is a ring-like. A ring-like n electrode is soldered to a pattern 74. Generally p electrode is made as for PD of a rear-face incoming radiational type to disc-like [instead of the shape of a ring / small]. On p mold field 75 near the front face, the disc-like (it is not ring-like) p electrode 76 is also in this example. Since a wire can carry out bond to this p electrode, it can make p electrode small. Since p electrode is small, pn junction is also narrowed and can narrow light-receiving area. Electrostatic capacity of pn junction is made small at a sake. For example, it is also possible to set the diameter of light-receiving to 50 micrometers - about 100 micrometers. In that case, the electrostatic capacity of junction is 0.2pF - 0.8pF. Since electrostatic capacity is small, the high-speed response of this PD can be carried out. Adoption of the rear-face incoming radiational type PD is indispensable for this invention. High-speed optical communication becomes possible by this.
[0046] The amplifier (amplifier) chip 77 is fixed to the side of the rear face of a substrate 70. The input of amplifier 77 is connected with p electrode of PD73 by the wire 78. The photocurrent of PD73 is amplified with the immediately near amplifier 77. Other electrodes of amplifier 77 are connected to the metallizing pattern 79. The input signal of PD is very feeble, and it provides amplifier 77 immediately in near so that it may amplify before a noise enters, since it is easy to receive a noise. If amplified, since the impedance of an output circuit will become low and will become strong in a noise, this is taken out

outside. This method is called PIN-AMP. As AMP77, Si-IC as an amplifying circuit and GaAs-IC can be used. Chip sizes are for example, 1mm angle - 2mm angle.
[0047] The 2nd dugout 72 of the 2nd substrate 70 is punched in the location in which the light of an optical fiber is reflected by WDM. The metallizing part of the same dimension as PD chip is prepared in the surrounding base of a dugout 72. Although this is for attaching PD, it also becomes the mark of the alignment of PD installation. Although the dimension of PD chip has the magnitude of 550-micrometer angle like point **, the diameter of the diameter of 50 micrometer - 100 micrometer of light-receiving area is small. Therefore, the 1st dugout 68 and the 2nd dugout 72 can be made for example, into diameter extent of 200 micrometer. Since the diameter of light-receiving of a photo detector is quite as large as 50 micrometers - 100 micrometers, alignment is easy.
[0048] The superstructure shown in drawing 9 can be called transmitting section. Only the transmitting section is produced and inspected and the excellent article is chosen. A substructure object is a receive section. A receive section also manufactures independently, and inspects and an excellent article is chosen. Since it produces independently and an excellent article is chosen, a stop is higher than the case where what coalesced from the start is made. When the whole is made from the start, even if which component is bad, the whole becomes a rejection and all components and activities become useless. Since this invention combines what was made separately, it can avoid such futility.
[0049] The transmitting section of an excellent article which passed inspection, and a receive section are made to coalesce like drawing 13 . Therefore, a mark is attached to the Si bench (the 1st substrate) 51 of a superstructure (transmitting section), and the ceramic bench (the 2nd substrate) 70 of a substructure object (receive section). For example, the through hole is punched in four corners of each substrate, and these can be considered as a mark. The metallized layer 64 of the inferior surface of tongue of the 1st substrate 51 is put on the metallized layer 71 of the top face of the 2nd substrate 70, and the relative position of substrates 51 and 70 is adjusted so that these marks may agree. It is good to decide on the location where high sensitivity is obtained, carrying out incidence of the light to an optical fiber at this time, and observing the output of PD73. If the optimal location is decided, substrates 51 and 70 will coalesce in the location.
[0050] Thermocompression bonding can perform lamination of a substrate. Thermocompression bonding will also heat a component (PD, LD, amplifier). When saying that he wants to make it coalesce at low temperature more, it is good to impose a supersonic wave in addition to thermocompression bonding. Since partial heating only of the metallizing side is carried out by the supersonic wave, it is more joinable at low temperature.
[0051] The condition of being stretched is shown in drawing 14 . The metallized layers 64 and 71 between a superstructure and a substructure object coalesce, and this serves as a grand side. LD62 to which a comparatively large current flows may serve as a generation source of a noise, and high PD and the high amplifier of an impedance tend to be influenced of a noise. However, since there is a large grand side that it is this structure between LD, PD, and AMP, a noise is intercepted. PD+AMP is electrically isolated with LD according to the grand side. The grand sides 64 and 71 have prevented the cross talk of a transmitting side and a receiving side.
[0052] Thus, the stretched module is further dedicated to a case. Drawing 15 shows the condition of having mounted in the case. Cases are containers, such as a metal and a ceramic. In that case, since there is a building envelope, hermetic sealing of the inert gas is filled up with and carried out. Drawing 15 shows the case of a ceramic case. In the case of metal casing, it is necessary to insulate the extraction part of a lead pin. Or resin mold or a plastic package can also be used for low-cost-izing.
[0053] A case 119 consists of a rectangle-like upper case 121 where it has the bottom case 120 of the shape of a closed-end rectangle, and a crown plate, in drawing 15 . A cave hole 122 is dug by the front face of the upper case 121. The bottom case 120 has the 1st step 123 in a front face, and has the 2nd step 124 on a rear face. Two or more dugouts 127 are dug by the 2nd step 124 of the bottom case 120. It is a hole for letting the lead pin 128 pass. The pattern (not shown) corresponding to the patterns 74 and 79 of drawing 11 (b) is formed in the top face of the 2nd step 124.
[0054] The 2nd substrate (ceramic bench) 71 of the module of this invention made to coalesce is put on

the steps 123 and 124 of the bottom case 120, and it fixes. PD73 and AMP77 are located in the building envelope of the bottom case 120. On the step 59, the monitor PD 129 is attached besides LD62 in this example. This is for detecting and supervising the output of LD62. Although there is no monitor PD in the example of drawing 13 - drawing 14 , PD129 is added in this example. In order to carry out the monitor of the laser output, having been known well puts in PD too much. The electrode patterns 74 and 79 at the bottom which appear in drawing 11 (b) connect with the pattern on a step 124 (not shown), and the amplifier 77 of a receive section and the electrode of PD73 are further connected to the lead pin 128.

[0055] The tip of an optical fiber is put into the cave hole 122 of the upper case 121, and it fixes to the V groove ahead of the Si bench (the 1st substrate) 51. Association of an optical fiber and a case is based on soldering, resin adhesion, etc. Metallizing of a part of front face of an optical fiber is carried out, and it solders in the hole of a case. Or adhesion immobilization can be carried out by the low resin of moisture permeability.

[0056] The end faces 125 and 126 of the upper case 121 are joined on the steps 123 and 124 of the bottom case 120. Inert gas is enclosed with the sealed case. The lead pin 128 is a terminal for giving supply voltage to a receive section (PD73 and amplifier 77) and the transmitting section (LD62, PD129), taking out an input signal, or giving a sending signal. By the sending signal, laser 62 drives and the transmitting light of lambda 1 (for example, 1.3 micrometers) comes out. This goes into lightguide 54. WDM66 is only penetrated and it goes into the core 57 of an optical fiber 56 from lightguide 54. This spreads to a base station.

[0057] lambda 2 sent from the station Receiving light (for example, 1.55 micrometers) goes into lightguide 54 from the optical fiber core 57, and is reflected by WDM66. This goes into the rear-face incoming radiational type PD 73 through dugouts 68 and 72. PD73 changes receiving light into a photocurrent. A photocurrent is immediately amplified by amplifier 77. This is taken out outside by one of the lead pins 128. Although the lead pin is arranged in the single tier in the section in this example in the second half of a case, that may not be right and a lead pin may be divided into the section the first portion and the second half. Combination with an electrical circuit can determine such lead pin distribution suitably.

[0058]

[Example] The optical transceiver module of this invention with the following parameters was manufactured. And the property was evaluated.

** Semiconductor laser LD of the transmitting section is MQW-LD (quantum well mold laser) whose luminescence wavelength is 1.3 micrometers. A chip size is 300micrometer(width of face) x300micrometer(die length) x100micrometer (thickness). A threshold current It is 7mA. It drove by 155Mbps signals by 50mA of peak currents, and the average fiber output of 1mW (0dBm) was obtained. PD for monitors is pin-PD of a waveguide mold which has an InGaAs euphotic zone with a thickness of 3 micrometers. It is the same size as LD chip (300micrometerx300micrometerx100micrometer).

[0059] ** A receive section is the receiving set of 1.55-micrometer light. To the light of 45-degree incidence, a WDM filter makes 1.3 micrometers penetrate and reflects 1.55 micrometers. Therefore, only 1.55 micrometers arrives at a receive section. PD of a receive section is the rear-face incoming radiational type PD which has the euphotic zone of InGaAs. Therefore, although no less than 1.3 micrometers and no less than 1.55 micrometers can be picked up, since only 1.55 micrometers comes here, 1.55 micrometers is detected. The dimension of PD is 550micrometer(width of face) x550micrometer(die length) x100micrometer (thickness). The diameter of light-receiving is 60 micrometers. Electrostatic capacity was 0.3pF to the bias of 2V. It is very small electrostatic capacity.

[0060] ** Amplifier (AMP) is GaAs-IC. Feedback resistance used the transimpedance circuit which is 1kohm.

** Receiving sensibility was measured using the above component. Making the error rate or less into ten to nine with the signal speed of 155Mbps(es), receiving sensibility was -40dBm. It turns out that it is high sensitivity very much.

[0061]

[Effect of the Invention] This invention can do the following outstanding effectiveness so.
** The transmitting section (LD) and a receive section (PD) can completely be manufactured separately, and inspection and a burn-in can be carried out separately, respectively. Each quality assurance can be performed certainly. By the method which unifies LD and PD at once, even if which component is bad, all components and all activities will become useless.
** Since the WDM filter is used, it becomes compact. A WDM filter can use the thing which carried out the laminating of the dielectric (optical) multilayers on the glass substrate, or the thing which carried out the laminating of the optical (dielectric) multilayers on the macromolecule thin film.
** Since it is letting bending and a pinhole pass to the down side, the scattered light from LD cannot go light into PD easily. That is, the cross talk of receiving light transmitting light hardly arises.
** Isolation of the transmitting-side and transmitting-side side which passes a high current (for example, 50-100mA) since the large gland (ground) is prepared between receiving sides, and the PIN-AMP side also treating the minute current below 1microA is carried out electrically. An electric cross talk is hardly produced, either.
** Since PD becomes a rear-face incoming radiational type, it can lower electrostatic capacity.

[Translation done.]